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RELATIVE VARIANCE PREFERENCES IN A CHOICE-AMONG-BETS PARADIGM

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The validity of the prime assumption of proper scoring rules (PSR), that people maximize subjective expected value (SEV), was tested in the case where SEV was assumed to equal EV. A choice-among-bets paradigm was used in which the lists of bets conformed to the requirements of a PSR. Both real and hypothetical payoff conditions were used, and in addition, EV, variance, and odds of the gambles were systematically varied. Of the 12 Ss only 3 tended to maximize EV under both real and hypothetical payoff conditions, while relative variance preferences can account for the decision

20.

strategies of the other Ss. Inferred strategies were simpler and more consistent during the real payoff sessions. The effect of the gambles' properties was idiosyncratic and no overall conclusions were drawn. The use of list of bets generated by a PSR as a response mode for inferring subjective probabilities is questioned because of the weakness of the SEV maximization assumption in this context.

-1-

RELATIVE VARIANCE PREFERENCES IN A CHOICE-AMONG BETS PARADIGM[1]

Technical Report

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RELATIVE VARIANCE PREFERENCES IN A CHOICE-AMONG-BETS PARADIGM[1]

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Most of the past research on subjective probability (SP) inference has been based on the direct estimation of SPs. There has been much debate about the possible problems introduced by the nature of this kind of estimation process (see Edwards, 1968). One problem is a tendency for Ss to state different likelihoods for an event depending upon the particular response mode used (Phillips and Edwards, 1966). Another serious problem is that Ss develop gaming strategies such that when it is optimal, in terms of maximizing EV, for them to state a probability estimate different from their true SP they do so.

To overcome these problems certain investigators interested in eliciting SPs have proposed using a special class of payoff functions known as proper scoring rules (Winkler and Murphy, 1968; Phillips and Edwards, 1966). A proper scoring rule (PSR) is a function that assigns a numerical score to the stated probability contingent upon that estimate and the event that actually occurs such that S can maximize his subjectively expected score only by stating a probability estimate equal to his true SP

(Toda, 1963). PSRs can be used with both direct and indirect estimation procedures.

One indirect estimation procedure using PSRs consists of generating a list of bets by a PSR and then using *S*'s selection of a particular bet from the list to infer his SP for that particular event determining the outcome of the bet. Each bet in this list is specified by an amount to win and an amount to lose. Each bet is optimal (maximum SEV) for a unique probability of winning.

The validity of inferring a particular SP from the choice of a bet from a list of bets rests critically on the assumption that the *S* maximizes SEV. In order to test this assumption directly, the *S*'s SPs are needed. There are at least three possible ways to obtain them. One is the use of an elicitation procedure using PSRs to obtain the SP. This, of course, is circular since it is necessary to assume that which is being tested. A second is the use of an elicitation procedure which makes no use of PSRs. However, either it must be assumed that this procedure yields the "correct" SPs or else the test reduces to a comparison of the two elicitation procedures. A third possibility is that the *S*'s SPs are actually equal to the objective probabilities. If this strong assumption can be made, then SEV and EV are equivalent and it suffices to test the validity of the EV maximization assumption.

Two kinds of factors that might influence whether *Ss* maximize EV in a choice-among-bets paradigm are the stimulus characteristics of the bets such as EV, variance, and odds and the procedural characteristics of the experiment such as response mode and payoff conditions.

Many studies have examined the effect of stimulus properties on choice behavior (Edwards, 1953, 1954; Lichtenstein, 1965; Coombs and Pruitt, 1960; Slovic and Lichtenstein,1968a; Slovic,Lichtenstein, and Edwards, 1965; Fryback, Goodman, and Edwards, 1973). No undisputed conclusions about the effects of different stimulus properties emerge from these studies. There have been studies which were concerned with procedural properties. Here too, there is no agreement. Edwards (1953) found that Ss preferred long shots (a low probability of winning a large amount) much more when gambling for real payoffs than when gambling for hypothetical stakes. Slovic (1969), however, reached the opposite conclusion. Edwards (1953) also found that Ss were equally consistent in their preferences under both real and hypothetical payoff conditions. Slovic, Lichtenstein, and Edwards (1965) found that Ss were more consistent when payoffs were hypothetical.

None of the previous studies that examined the effect of different stimulus properties on choice behavior have used lists of bets conforming to the specifications of a PSR. Furthermore, few of these studies have used both real and hypothetical payoff conditions or used different response modes. Those studies which were mainly concerned with determining the effect of varying procedural properties have minimized varying the stimulus properties of the gambles used.

The present experiment examines choice behavior and tests the SEV maximization assumption (where SEV and EV are assumed to be equal) when both the stimulus properties of the gambles and the procedural characteristics of the experiment are varied simultaneously.

Method

Design.--A stimulus consisted of a list of seven bets, each bet specified by an amount to win and an amount to lose. All seven bets had the same probability of winning. Since the probabilities of winning and losing were explicitly stated in terms of their likelihood of occurrence as determined by a random device, it was assumed that the S's SPs did in fact equal the true objective probabilities. As required by a PSR, the lists of bets were single peaked with respect to EV for that probability of winning and were strictly increasing in dollar amounts to win and in dollar amounts to lose. Differences in EV between adjacent bets were constant within each list in the main design. Examples of lists of bets are presented in Table I.

Insert Table I about here

Each of these lists of bets was categorized with respect to five independent variables: (a) the level (EV) of the optimal (maximum EV) bet (LOB); (b) the difference in EV between adjacent bets (ΔEV); (c) the average difference between the amount to win and the amount to lose over all bets in the list (A-B); (d) the bet number position (from 1-7) of the optimal bet (OBP); and (e) the odds level associated with each list of bets (ODDS). There were two levels of LOB, \$.16 and \$.08; two levels of ΔEV, \$.16 and

$.08; two levels of A-B, $8.44 and $13.83; four levels of OBP, bet numbers 1, 3, 5, and 7; and four levels of ODDS, 2:1, 5:1, 8:1, and 11:1 against winning.

Only the variables OBP and ODDS were counter balanced, however, each was factorial with the other three variables. The 16 lists in the low A-B condition were constructed by trial and error to satisfy the requirements of a PSR and the requirements of the independent variables. A reasonable tolerance (± $.01) in meeting these requirements was necessary since all bets were expressed in even nickel units. The 16 high A-B lists were derived from the corresponding low A-B lists by the following EV preserving linear transformation: let a low A-B bet = $(p)(y) + (q)(z)$ where p and q are the probabilities of winning and losing, respectively, and y and z are the amounts to win and to lose, respectively. Then a high A-B bet = $(p)(y+a) + (q)\left[z-(p/q)a\right]$. A value of $4.40 was used for a except for ODDS level 5:1 where $4.50 was used to preserve even nickel units.

In addition to these 32 lists of bets there was a particular list, the constant list (CL), which appeared seven times, each time at a different odds level, such that each time a different bet was the maximum EV bet. The order of presentation of lists in the main design was random within blocks (eight lists) where a block was the 2 X 2 X 2 factorial of LOB X ΔEV X A-B. The seven versions of the CL were inserted randomly into the following seven positions in the presentation order -- 5, 10, 15, 20, 25, 30, and 35. All *S*s saw these 39 lists in all sessions. A summary of the experimental design is presented in Table 2.

Insert Table 2 about here

Procedure.--Each *S* participated in four experimental sessions each lasting from 30 minutes to two hours. During two of the sessions (G sessions) *S* indicated his first, second, and third choices from each list. Then his first choice was played for real money before he proceeded to the next list. During the other two sessions (RO sessions) *S* rank ordered all seven bets in each list according to his preference for playing them; however, no bets were actually played in these sessions. All sessions were conducted individually and no *S* participated in more than one session per day.

The *S*s were arbitrarily assigned to two payoff order conditions. In condition GGRR *S*s participated in the two G sessions first and then in the two RO sessions. In condition RRGG the order was reversed. Before the *S*'s first session, he was given 12 practice lists which were representative of the independent variables.

The random device used to determine the outcome of bets during the G sessions was a standard roulette wheel. The numbers 0 and 00 were disregarded leaving only 36 possible outcomes. The odds for each list of bets was represented by the number of roulette numbers on which *S* could win and the number of roulette numbers on which S could lose. For each list of bets S was allowed to place the appropriate number of chips on whichever roulette numbers he wished. The gambles were displayed on a cathode ray tube by a PDP-7 computer in a format similar to that in Table I.

The S could ask about his current money status any time during a G session. In order to maintain the cumulative winnings for each G session within a range of \$3.75 to \$10.00, six additional sets of lists were constructed. Three of these sets had positive EVs (approximately \$6, \$12, and \$18 assuming optimal choices) and the other three had corresponding negative EVs. The lists used in these six sets were somewhat different from those in the main design. On half of the lists S could only win (W-W) and on the other half S could only lose (L-L). The roulette wheel only determined which of the dollar amounts was involved. The S always saw an equal number of W-W and L-L lists regardless of which of the six sets was being used. All or any part of each set could be presented to the S at any time. Neither E nor S knew in advance how many of the lists would be presented and no S acknowledged recognizing the purpose of these sets of lists.

During RO sessions S was given a booklet with 71 lists of seven bets consisting of the 32 lists in the main design, the seven odds levels of the CL, 20 lists with constant EV within the list, and six pairs of W-W and L-L lists. Each list was on a separate page in the format shown in Table I. Written instructions were provided and E answered all questions before leaving S to work through the booklet alone.

Subjects.--The Ss were 12 college age men and women who responded to an advertisement in the University of Michigan student newspaper. Seven of the nine men were UM students and one was an ex-student. Two of the three women were UM students, the other an ex-student. Prospective Ss, responding to the advertisement by phone, were informed that the experiment involved four sessions, in each of two sessions they would be paid $5 and in the other two, gambling for real money would determine their pay. They were told that most Ss win money, but that it was possible to lose some of their own money in the gambling sessions. Several inquirers declined to participate. Final pay ranged from $15.65 to $31.45.

Results

Method of analysis.--In order to assess the effect of different stimulus and procedural properties on choice behavior and to test the EV maximization assumption, two statistical approaches were taken in the within-S analysis. In the first approach the effect of the stimulus properties was assessed by means of the analysis of variance (ANOVA). In the second approach, a Bayesian strategy analysis, the relative likelihood of the EV maximization strategy was determined with respect to other possible decision strategies, for each of the payoff conditions.

The ANOVA was performed with respect to two dependent variables -- the absolute deviation (ABS DEV) from the optimal bet, in bet number units which are linear with EV within each level of ΔEV, and the actual bet number chosen (BET NUM), which is monotone with relative A-B. For each dependent variable the following measures were examined: (a) the proportion of variance accounted for (PVAF) by each effect and by the entire experimental design, and (b) the consistency with which these variables accounted for variance.

The PVAF figures were calculated from each ANOVA using the following formula derived in Hays (1963, p. 407):

$$\text{PVAF} = \frac{\text{SS(effect X)} - \text{df(effect X)} \times \text{MS(error)}}{\text{MS(error)} + \text{SS(total)}}$$

With the exception of OBP, assessing PVAF is straight forward, i.e., the greater the PVAF for effect i the greater the influence of that variable on the decision strategy. For OBP, the greater the PVAF with respect to ABS DEV the greater the deviation from the EV maximization strategy (a perfect EV maximizer would have zero PVAF for OBP under ABS DEV while always picking the same bet number would result in 99 PVAF). With repsect to BET NUM, however, a greater PVAF reflects a greater deviation from a constant relative variance strategy (always choosing the same bet number would result in zero PVAF for OBP under BET NUM while maximizing EV would result in 99 PVAF).

The consistency with which these variables accounted for variance was measured by the sum over all effects of the absolute difference between PVAF by effect i in session 1 and in session 2. That is, $C(\text{wrt PVAF}) = \Sigma_i \left[|\text{PVAF by effect } i \text{ session } 1| - |\text{PVAF by effect } i \text{ session } 2| \right]$ where i ranges over all effects. The scale is inversely related to consistency and extends from 0 to 200. This measure, however, is with respect to magnitude only and not direction.

In order to quantify the relative merit of the EV maximization strategy and of several simple strategies that might easily have been adopted by Ss, the second approach was a Bayesian analysis. In a Bayesian data analysis the basic interest is to assess the likelihood of an hypothesis in light of the experimental data, i.e., $P(H|D)$. In most cases it is more useful and convenient to assess the relative likelihood of pairs of hypotheses. In this case the following form of Bayes's theorem facilitates the

computation
$$\frac{P(H_1|D)}{P(H_2|D)} = \frac{P(D|H_1)}{P(D|H_2)} \cdot \frac{P(H_1)}{P(H_2)} ,$$

or

$$\Omega_1 = LR \cdot \Omega_0 ,$$

i.e., the posterior odds of H_1 over H_2 in light of the data is equal to the prior odds of the hypotheses (before the data) times the likelihood ratio (LR), the relative impact of the data with respect to the two hypotheses. The prior odds (Ω_0) may be purely subjective or based upon previous experimentation. In any event it is independent of the data. In view of the "principle of stable estimation" (see Edwards, Lindman, and Savage, 1963) it is not unreasonable to assume a uniform prior distribution (i.e., $\Omega_0 = 1.0$ for each pair of hypotheses) over all hypotheses.

In the present experiment it was of interest to compare the EV maximization strategy with the following strategies dealing with relative variance preference: S always chooses (a) bet number 1 (low relative variance preference), (b) bet numbers 1-3 (low relative variance preference), (c) bet numbers 3-5 (middle relative variance preference), and (d) bet numbers 5-7 (high relative variance preference). Since these are not mutually exclusive it seemed appropriate to provide a standard frame of reference by taking LRs for all strategies with respect to the random strategy, where the probability of choosing any bet equals 1/7th. To calculate the posterior odds for each of these five strategies over the random strategy, a set of prior odds and LR are needed for each pair. It is trivial to calculate the LRs once the necessary conditional probabilities are available. Thus the conditional probability of each datum for each given hypothesis is needed, i.e., the probability density function (pdf) over the data space (the seven alternatives) for each of the hypotheses.

With the present deterministic definition of the hypotheses as "S always chooses bet number i" the pdf has a probability of 1.0 for bet number i and a probability of 0.0 for the other six bet numbers. This is unacceptable theoretically since even one deviant choice disallows the hypothesis and it is unacceptable practically since calculation with 1.0's and 0.0's may result in undefined LRs. Rather it is more reasonable to reformulate the hypotheses in order to allow for error in the S's choices. That is, "S 'means' to choose bet number i always, but sometimes errs." In terms of the pdf for the hypothesis, every alternative must have a nonzero probability associated with it, so that no choice completely disallows any hypothesis.

To accomplish this, the assumption was made that the discrepancies between the observed choices from a list of bets in session 1 and in session 2 represented an error from the S's true strategy. To estimate these error rates a 7 X 7 matrix was constructed using the data from all Ss. The rows of the matrix represented the bet number chosen in session 1 and the columns represented the bet number chosen in session 2. A tally in the ijth entry indicates that some *S* on some list of bets chose bet number i in session 1 and bet number j in session 2. Offdiagonal entries represent discrepancies of choice and hence assumed errors.

Four matrices were constructed one from each of the four levels of the optimal bet position. (This was necessary since the EV maximization strategy predicts a different bet number depending on which is optimal.) For the four strategies dealing with relative variance the sum of the four submatrices was used Since each *S* participated in two sessions under each of the payoff conditions, each matrix was averaged over the two conditions. In each case the matrix was added to a matrix with 1's in every cell. This corresponds to revising uniform priors over the cells with the data. [Although the motivation is Bayesian, this matrix addition does not relate to the overall Bayesian analysis per se. It is merely part of the procedure to determine the pdfs for the strategies.] This also ensured that there were no zero entries.

For each of the five strategies two estimates of the error rates were obtained from the appropriate matrix. That is, for the strategy defined by "*S* 'means' to pick bet number i always, but sometimes errs" the proportion of tallies in each entry of row i represents the distribution of choices given that bet number i was chosen in session 1. From column i the analogous distribution given that bet number i was chosen in session 2 was obtained. The final distribution, the average of these two, was used as the estimate of the pdf for this strategy. Thus the probability of choosing bet number i was estimated by the proportion of repeated choices of bet number i and the remaining probabilities were estimated by the corresponding error rates. Thus all probabilities were non-zero and reasonable LRs could be obtained from these probability distributions. The overall LR for each session was calculated by multiplying together all the LRs for each datum.

The pdfs obtained by this method for the relative variance preference strategies and the EV maximization strategy are displayed in Figures 1 and 2, respectively. The original representations of the hypotheses favoring three of the bets (e.g., 3-5) are of the form S picks any one of the bets in the equivalence class bet a, bet b, or bet c with probability X. The random strategy predicts that the probability of choosing a bet from this equivalence class is 3/7th. The equivalent representations in Figure 1 are of the form S picks either bet a, bet b, or bet c each with probability X/3. In this case the random strategy predicts that the probability of choosing any of the three bets is 1/7th.

Insert Figures 1 and 2 about here

Main design.--Subject numbers 1-6 represent the Ss in payoff order GGRR while 7-12 represent condition RRGG.

The *Ss* were categorized according to an inferred strategy based upon the following results: (*a*) percentage of optimal and/or modal choices, (*b*) LR for the EV maximization hypothesis with respect to random, (*c*) LR for the most likely relative variance hypothesis with respect to random, (*d*) PVAF by OBP with respect to the ABS DEV dependent variable, and (*e*) PVAF by OBP with respect to the BET NUM dependent variable. Results for the EV maximization hypothesis and the most likely relative variance hypothesis must both be considered since these hypotheses are not mutually exclusive. A complete summary of these statistics is contained in Table 3.

Insert Table 3 about here

The strategies were inferred from these results based upon *post hoc* criteria. Although the evidence for a strategy other than the one inferred often seems strong in an absolute sense, the relative likelihood is clearly smaller.

Subjects 3, 10, and 12 were classified as EV maximizers regardless of payoff condition since each has satisfied the following criteria: (*a*) a minimum of 70% optimal choices, (*b*) a minimum LR of 7.7×10^{46} for the EV maximization hypothesis, (*c*) a maximum LR of 1.4×10^{2} for the most likely relative variance hypothesis, (*d*) a maximum PVAF of 1.5 with respect to ABS DEV, and (*e*) a minimum

PVAF of 61.5 with respect to BET NUM.

Subjects 4, 6, and 9 were categorized as having strong low relative variance preferences regardless of payoff condition since (a) a minimum of 53% bet number 1 choices, (b) a maximum LR of 9.9×10^{-1} for the EV maximization hypothesis, (c) a minimum LR of 1.2×10^{30} for the "always pick bet number 1" hypothesis, (d) a minimum PVAF of 52.5 with respect to ABS DEV, and (e) a maximum PVAF of 8.4 with respect to BET NUM were obtained.

Under the real payoff condition, Ss 1, 5, 7, 8, and 11 displayed moderate low relative variance preferences, as indicated by (a) a minimum of 33% bet number 1 choices (percentage of bet number 1 choices was at least as great as the percentage of optimal choices for each of these Ss), (b) a maximum LR of 7.2×10^{3} for the EV maximization hypothesis, (c) a minimum LR for one of the two low relative variance hypotheses of 4.3×10^{5}, (d) a minimum PVAF of 29 with respect to ABS DEV, and (e) a maximum PVAF of 53.5 with respect to BET NUM.

Under hypothetical payoffs, Ss 1, 5, and 11 tended to maximize EV as shown by (a) a minimum of 44% optimal choices, (b) a minimum LR of 2.7×10^{6} for the EV maximization hypothesis, (c) a maximum LR of 1.1×10^{-1} for the most likely relative variance hypothesis, (d) a maximum PVAF of 18.5 with respect to ABS DEV, and (e) a minimum PVAF of 8.5 with respect to BET NUM. However, Ss 7 and 8 were classified as having middle relative variance strategies since their most likely hypothesis was "always pick bet numbers 3-5."

Although S 2 tended to maximize EV during the real payoff condition -- 39% optimal choices and a LR of 5.8×10^6 for the EV maximization hypothesis -- his most likely strategy for the hypothetical payoff condition was the random hypothesis.

Table 4 contains a summary of the classification of Ss according to inferred strategies.

Insert Table 4 about here

Although the PVAFs were noteworthy in a few isolated cases, no consistent trend within or between Ss seemed apparent. The consistency with which the independent variables accounted for variance was greater for the hypothetical payoff condition for most Ss. See Table 5. However, there was no trend with respect to the inferred strategy classification. Nine Ss were inferred to have the same strategy for the two G sessions, while 11 Ss were inferred to have the same strategy for the two RO sessions.

Insert Table 5 about here

The percentage of orderings which were folded along the variance dimension were very high for all Ss for both payoff conditions regardless of their inferred strategy. For the G sessions (first three choices only) the range was 67% to 100%. For the RO sessions (all seven choices) the range was 63% to 100%.

For the RO sessions, restricted to the first three choices only, the range was 80% to 100%. In all three cases the median was 97%.

Constant list.--Table 6 contains the percentage of optimal choices and the percentage of modal choices for the CL. Most Ss had a smaller percentage of optimal choices (11 in G sessions and 9 in RO sessions) than they had had in the main design. Likewise most Ss had a higher percentage of choices for their modal choice (7 in G sessions and 11 in RO sessions) than in the main design. Four of the five Ss who did not have higher percentages in the G sessions had been classified as having a low relative variance strategy in G sessions of the main design.

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Insert Table 6 about here

- -

W-W and L-L lists.--Table 7 contains the percentage of optimal choices for the W-W and the L-L lists. The three Ss classified as EV maximizers (3, 10, and 12) generally had a smaller percentage of optimal choices than they had had in the main design. The three Ss classified as having strong low relative variance preferences (4, 6, and 9), however, had larger percentages of optimal choices here. There was no trend for the remaining Ss.

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Insert Table 7 about here

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Discussion

The results of this experiment lead to the rejection of the EV maximization hypothesis in a choice-among-bets situation, particularly when gambling for real money is involved. If the assumption that the Ss' SPs equaled the true objective probabilities was valid, then the SEV maximization assumption must also be rejected. Consequently, the use of a choice-among-bets paradigm as an indirect estimation procedure for inferring SPs is questionable.

Only 3 of the 12 Ss maximized EV consistently, while relative variance preferences seemed likely strategies for most of the other Ss indicating the influence of the dollar amounts per se on the decision strategies. This is consistent with the framework presented by Slovic and Lichtenstein (1968b) in which each gamble is described in terms of four risk dimensions - probability of winning, probability of losing, amount to win, and amount to lose - since the probabilities of winning and losing were constant within each list.

More evidence for the dominance of dollar amounts was indicated by the pronounced relative variance preferences exhibited on the constant list. This is reasonable considering that the range of A-B for the constant list was greater than the range on any of the lists in the main design. In fact, five Ss displayed strong preferences for particular bet numbers, including (for the RO sessions) two of the three Ss classified as EV maximizers in the main design.

At least for the six *Ss* with the same inferred strategy for both payoff conditions, the reliability of that strategy was degraded for the "non-standard" lists of bets such as the W-W and L-L lists. Unfamiliar situations may well tend to make *Ss* less extreme in their decision strategies. Conversely, the simple strategies adopted for the CL may be due to over familiarity with the dollar amounts causing a total neglect of the odds levels.

The greater consistency of most *Ss* during the hypothetical payoff condition agrees with the findings of Slovic, Lichtenstein, and Edwards (1965) and Slovic (1969). Slovic et al. concluded that the orderly data and simple law of perferences in the Coombs and Pruitt (1960) study were due to boredom induced by *Ss*' having to make many choices with no real stakes involved. Assuming that it is a simpler decision strategy to always choose low relative variance bets than to choose the maximum EV bet, the results of the present experiment disagree with their conclusion. While playing for real stakes eight *Ss* tended to choose low relative variance bets and only four tended to maximize EV. During the hypothetical sessions, however, six *Ss* tended to maximize EV, only three adopted low relative variance strategies, two adopted middle relative variance strategies, and one appeared random.

The effect of varying the stimulus properties was very idiosyncratic and no overall conclusions could be drawn. Of interest was the apparent salience of relative variance. It is possible that the preferred level of absolute variance was lower for many Ss than that used in the main design and hence low relative variance preferences were prevalent.

The strategy analysis employed in this study rests heavily on Bayesian techniques. Basically, this involves two quantities, prior odds and LRs. The prior odds are purely subjective and may work with or against the data, i.e., the LRs. In most cases, the LR for the favored hypothesis was so much greater than that for any other hypothesis that virtually all priors would lead to the same conclusion.

In summary, most Ss did not maximize EV with any reliability and the effect of the manipulation of the stimulus properties of the gambles was slight and idiosnycratic. Relative variance preferences seem likely hypotheses for the inferred strategies of most Ss. Although within-S consistency was greater for most Ss during the hypothetical payoff condition, inferred decision strategies were simpler for the real payoff condition.

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Footnotes

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Table I

Typical Lists of Bets

	WIN ON 3	LOSE ON 33	EV[1]
1.	7.70	.70	.00
2.	9.80	.80	.08
3.	11.80	.90	.16
4.	12.55	1.05	.08
5.	13.20	1.20	.00
6.	14.40	1.40	-.08
7.	15.65	1.65	-.16

	WIN ON 6	LOSE ON 30	EV
1.	1.70	1.40	-.88
2.	2.95	1.45	-.72
3.	4.60	1.60	-.57
4.	6.35	1.75	-.40
5.	7.80	1.85	-.24
6	9.00	1.90	-.08
7.	10.75	2.05	.08

[1] The EVs were not displayed to the Ss.

Table 2

Summary of Experimental Design

	Low A-B 8.44							High A-B 13.83					
	High LOB .16			Low LOB .08				High LOB .16			Low LOB .08		
	List #	Odds	OBP	List #	Odds	OBP		List #	Odds	OBP	List #	Odds	OBP
	34	5:1	1	37	8:1	3		9	5:1	1	27	8:1	3
Low EV	22	8:1	5	2	2:1	1	Low EV	17	8:1	5	8	2:1	1
.08	3	11:1	3	18	11:1	7	.08	28	11:1	3	31	11:1	7
	19	2:1	7	29	5:1	5		38	2:1	7	13	5:1	5
	1	8:1	7	7	11:1	5		11	8:1	7	33	11:1	5
High EV	16	11:1	1	23	2:1	3	High EV	24	11:1	1	14	2:1	3
.16	26	2:1	5	12	5:1	7	.16	39	2:1	5	21	5:1	7
	36	5:1	3	32	8:1	1		6	5:1	3	4	8:1	1

	List #	Odds	OBP	List #	Odds	OBP
The	5	3:1	7	25	5:1	6
Constant	10	6.2:1	5	30	17:1	2
List	15	35:1	1	35	8:1	4
	20	11:1	3			

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Table 3

Statistics Relevant for Strategy Analysis

	Percentage of optimal choices	Percentage of modal choices		LR for the EV maximization hyp. with respect to random	LR for most likely rel. var. hyp. with respect to random		PVAF by OBP (sess. 1, sess. 2)	
		Bet #	%	random	Hyp.	LR	with respect to ABS DEV	with respect to BET NUM
S # 1 G cond.	36	1	44	7.2×10^{3}	1-3	1.0×10^{6}	26,43	06,21
RO cond.	44	1	27	2.7×10^{6}	3-5	1.1×10^{-1}	00,08	27,49
S # 2 G cond.	39	1	42	5.8×10^{6}	5-7	1.3×10^{1}	00,28	16,28
RO cond.	25	1	27	5.3×10^{-6}	3-5	4.0×10^{-3}	00,03	17,00
S # 3 G cond.	70	3	25	2.6×10^{20}	3-5	7.8×10^{0}	02,00	44,99
RO cond.	92	1,7	25	8.3×10^{35}	3-5	1.8×10^{1}	00,00	99,99
S # 4 G cond.	25	1	75	5.8×10^{-1}	1	2.3×10^{25}	05,70	00,00
RO cond.	22	1	64	2.9×10^{-4}	1	2.9×10^{19}	77,58	00,00
S # 5 G cond.	42	1	61	1.6×10^{11}	1	2.2×10^{14}	30,28	21,42
RO cond.	75	1	31	1.7×10^{28}	3-5	4.0×10^{-1}	13,24	82,80
S # 6 G cond.	27	1	72	1.6×10^{1}	1	1.0×10^{26}	59,84	13,00
RO cond.	23	1	61	6.2×10^{-2}	1	5.5×10^{18}	78,77	00,03

Table 3 (cont.)

Statistics Relevant for Strategy Analysis

	Percentage of optimal choices	Percentage of modal choices		LR for the EV maximization hyp. with respect to random	LR for most likely rel. var. hyp. with respect to random		PVAF by OBP (sess. 1, sess. 2)	
		Bet #	%	random	Hyp.	LR	with respect to ABS DEV	with respect to BET NUM
S # 7 G cond.	34	1	45	6.2×10^{3}	1-3	2.2×10^{10}	39,57	21,19
RO cond.	30	1	30	2.2×10^{0}	3-5	4.0×10^{0}	00,13	13,35
S # 8 G cond.	33	1	45	8.4×10^{0}	1-3	1.3×10^{12}	38,76	01,37
RO cond.	20	3	27	1.6×10^{-11}	3-5	9.3×10^{2}	23,44	23, 4
S # 9 G cond.	28	1	42	5.8×10^{-2}	1-3	3.0×10^{13}	83,67	07,12
RO cond.	23	1	64	2.2×10^{-2}	1	1.8×10^{25}	52,63	00,15
S #10 G cond.	98	1,3,7	25	9.0×10^{39}	3-5	4.3×10^{0}	00,00	99,99
RO cond.	97	1,3,7	25	9.0×10^{38}	3-5	4.3×10^{0}	00,00	99,99
S #11 G cond.	33	1	33	8.1×10^{1}	1-3	4.3×10^{5}	24,45	58,49
RO cond.	45	1,7	27	4.0×10^{9}	5-7	4.5×10^{-3}	00,00	06,13
S #12 G cond.	84	7	31	7.0×10^{30}	3-5	1.1×10^{1}	00,00	99,99
RO cond.	56	7	38	1.1×10^{16}	5-7	5.2×10^{0}	06,00	23,25

Table 4

Grouping of Subjects According to Inferred Strategy

EV maximization in both payoff conditions	Low relative var. preference in both payoff conditions	Low relative var. preference in the real payoff condition		EV maximization in the real payoff condition, random in the hypothetical
		EV maximization for hypothetical	Middle relative var. for hypothetical	
S # 3	S # 4	S # 1	S # 7	S # 2
S #10	S # 6	S # 5	S # 8	
S #12	S # 9	S #11		

Table 5

Consistency with which Variables Accounted for Variance

	Consistency wrt ABS DEV	Consistency wrt BET NUM		Consistency wrt ABS DEV	Consistency wrt BET NUM
S # 1 G cond.	53	66	S # 7 G cond.	67	36
RO cond.	46	37	RO cond.	47	52
S # 2 G cond.	71	64	S # 8 G cond.	69	126
RO cond.	41	64	RO cond.	52	47
S # 3 G cond.	68	106	S # 9 G cond.	32	58
RO cond.	0	0	RO cond.	35	58
S # 4 G cond.	72	33	S #10 G cond.	0	0
RO cond.	39	39	RO cond.	0	0
S # 5 G cond.	43	66	S #11 G cond.	92	46
RO cond.	52	11	RO cond.	48	79
S # 6 G cond.	57	83	S #12 G cond.	0	0
RO cond.	13	60	RO cond.	79	42

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Table 6

Summary of Statistics for the Constant List

	Percentage of optimal choices	Percentage of modal choices			Percentage of optimal choices	Percentage of modal choices	
		Bet #	%			Bet #	%
S # 1 G cond.	.14	1	.57	S # 7 G cond.	.29	1	.38
RO cond.	.14	1	.93	RO cond.	.14	1	1.00
S # 2 G cond.	.14	1	.29	S # 8 G cond.	.21	2	.29
RO cond.	.29	5	.43	RO cond.	.21	3 or 4	.29
S # 3 G cond.	.21	1	.43	S # 9 G cond.	.29	4	.71
RO cond.	.36	1	.71	RO cond.	.14	3	.78
S # 4 G cond.	.14	1	.50	S #10 G cond.	.57	7	.36
RO cond.	.14	1	.50	RO cond.	.14	1	1.00
S # 5 G cond.	.14	1	.71	S #11 G cond.	.29	3	.36
RO cond.	.14	1	1.00	RO cond.	.57	3 or 7	.29
S # 6 G cond.	.14	1	.71	S #12 G cond.	.43	7	.36
RO cond.	.07	2	.64	RO cond.	.43	1	.43

Table 7

Percentage of Optimal Choices

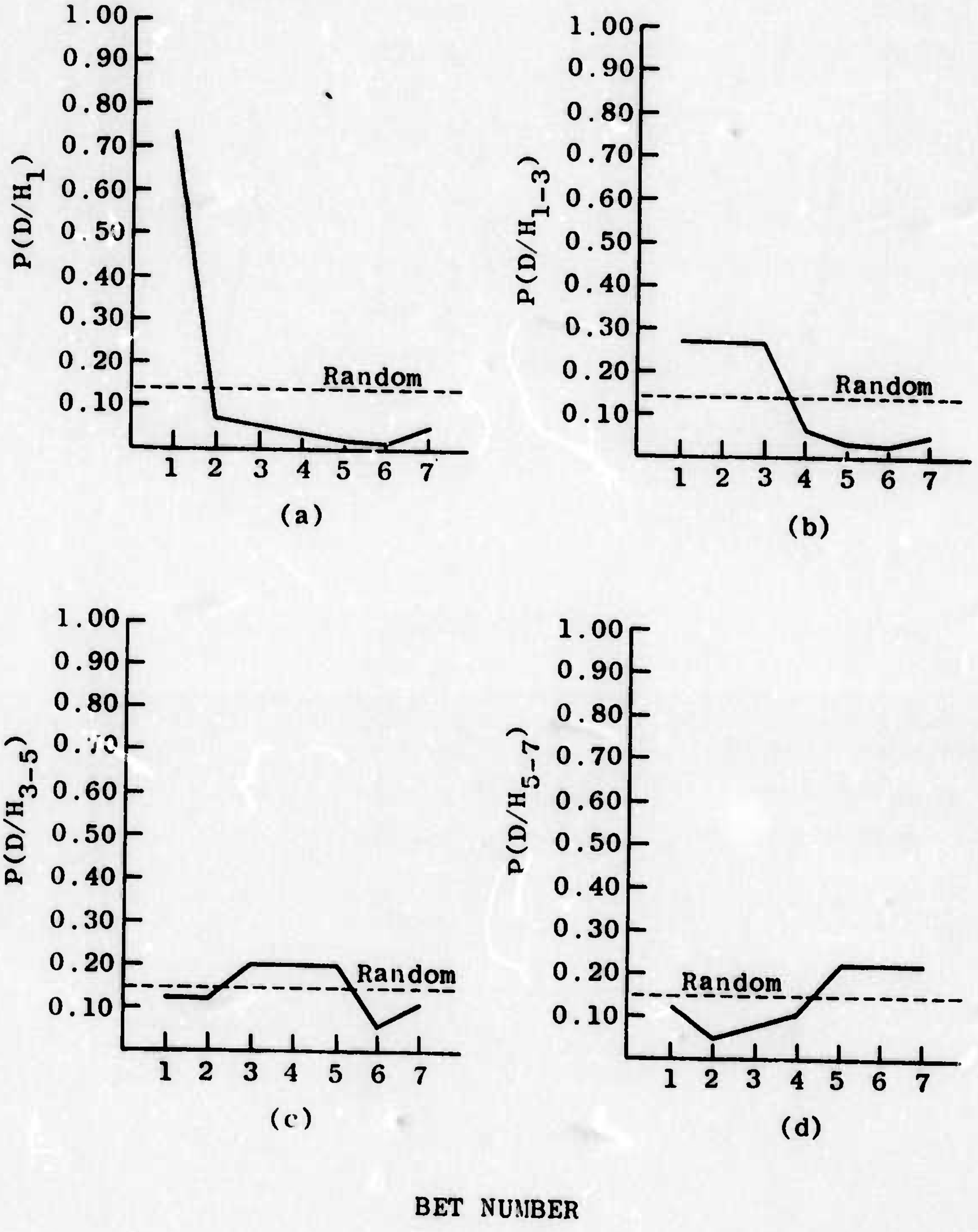
For W-W and L-L Lists

	W-W	L-L		W-W	L-L
S # 1 G cond.	.30	.25	S # 7 G cond.	.32	.16
RO cond.	.75	.25	RO cond.	.42	.00
S # 2 G cond.	.48	.48	S # 8 G cond.	.40	.40
RO cond.	.08	.41	RO cond.	.25	.33
S # 3 G cond.	.48	.55	S # 9 G cond.	.33	.42
RO cond.	.50	.50	RO cond.	.58	.58
S # 4 G cond.	.43	.35	S #10 G cond.	.78	.56
RO cond.	.17	.25	RO cond.	.83	.93
S # 5 G cond.	.73	.40	S #11 G cond.	.50	.21
RO cond.	.50	.50	RO cond.	.33	.25
S # 6 G cond.	.37	.37	S #12 G cond.	.57	.50
RO cond.	.17	.58	RO cond.	.50	.75

Figure Captions

Fig. 1. The pdfs for the relative variance preference strategies predicting (a) bet number 1, (b) bet numbers 1-3, (c) bet numbers 3-5, and (d) bet numbers 5-7.

Fig. 2. The pdfs for the EV maximization strategy when the optimal bet is number (a) 1, (b) 3, (c) 5, and (d) 7.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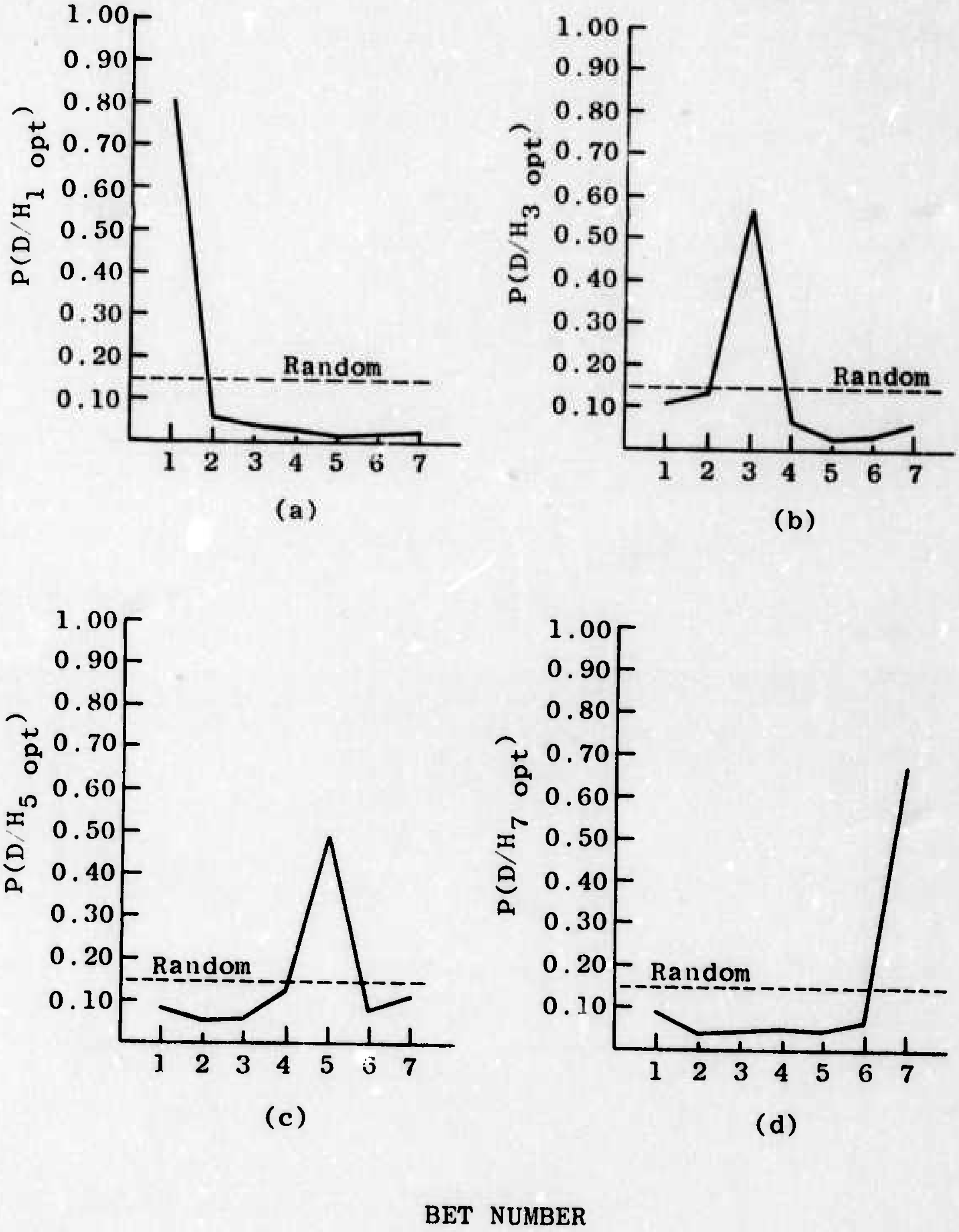
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
P(D/H1)
Random
1 2 3 4 5 6 7
(a)
P(D/H1-3)
Random
1 2 3 4 5 6 7
(b)
P(D/H3-5)
Random
1 2 3 4 5 6 7
(c)
P(D/H5-7)
Random
1 2 3 4 5 6 7
(d)
BET NUMBER


1.00
0.90
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0.10
$P(D/H_1\ opt)$
Random
1 2 3 4 5 6 7
(a)
$P(D/H_3\ opt)$
Random
1 2 3 4 5 6 7
(b)
$P(D/H_5\ opt)$
Random
1 2 3 4 5 6 7
(c)
$P(D/H_7\ opt)$
Random
1 2 3 4 5 6 7
(d)
BET NUMBER